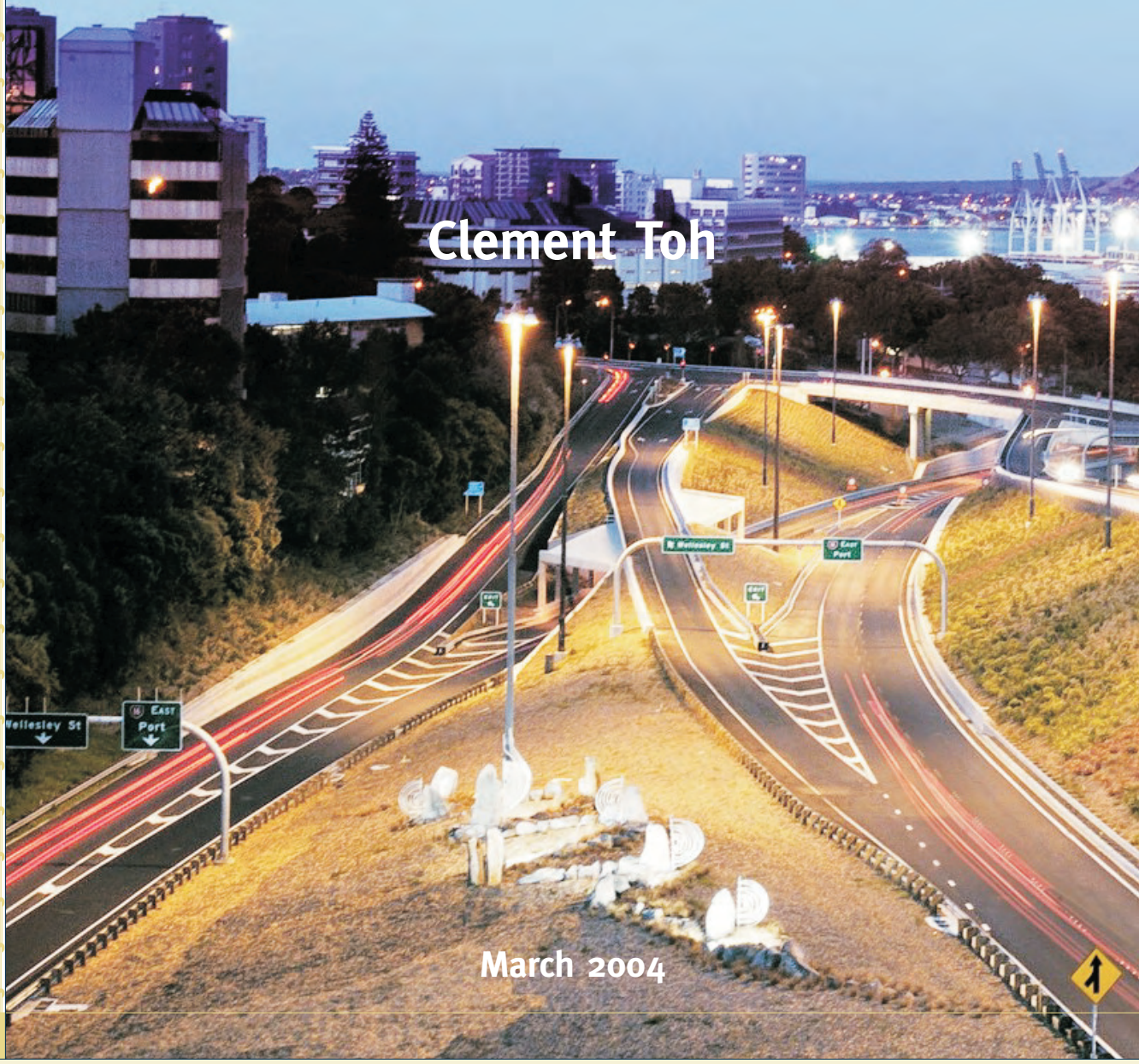
CENTRE FOR ADVANCED ENGINEERING ▸ UNIVERSITY OF CANTERBURY CAMPUS ▸ CHRISTCHURCH ▸ NEW ZEALAND

An Analysis of the Contribution of New Zealand's Construction Sector to the National Economy

Clement Toh



March 2004

Mail: Private Bag 4800, University of Canterbury Campus
Street Address: 39 Creyke Road, Ilam
Phone: 03 364 2478 Fax: 03 364 2069 e-mail: cae@cae.canterbury.ac.nz www.caenz.com

An Analysis of the Contribution of New Zealand's Construction Sector to the National Economy

Research Project completed as part of
Masterate of Engineering Management

Clement Toh

March 2004

Publisher

Centre for Advanced Engineering
University of Canterbury Campus
Private Bag 4800
Christchurch
New Zealand

Preface

The Centre for Advanced Engineering (CAE) has a long track record of successful infrastructure-related programmes focussed on bringing about process improvements in infrastructure delivery and achieving improved business performance for the benefit of New Zealand. Under-achievement in the sector impacts not only on the profitability of those engaged in infrastructure provision, but also materially affects New Zealand's capability to meet its broader economic and social goals.

Poor performance in construction was highlighted at a CAE conference "*The Contract in Successful Project Management"*, held in Christchurch, February 2002. Further consultation with industry players since that conference has confirmed the wide-held view that there is significant scope for improvement against key performance indicators when measured internationally. The question we asked was, how might we quantify the contribution made by the sector to the New Zealand economy, and the benefits that might accrue at a national economic level from improvements in production efficiency?

This project report sets out research carried out by Clement Toh as part of a Masterate of Engineering Management in response to these questions. Clement's research was undertaken with funding support from CAE and the FRST Enterprise Scholarship scheme. The report brings together industry statistics and economic data from a variety of sources and makes comparisons with similar data published internationally. It was not intended that the report provide an exhaustive assessment of the topic, but rather that it bring together key factors and considerations to serve as future reference material for ongoing CAE work on key performance indicators as a measurement of industry effectiveness.

To this end the report is published as a basis for catalysing discussion and feedback on the issues raised by the author. CAE's position of independence provides it with the opportunity to take both a detached and, perhaps, wider view of issues. It does so with the intent of adding value to the various stakeholder groups actively engaged in this essential industry sector.

R J (George) Hooper
Executive Director
May 23, 2004

Executive Summary

This report explores the nature of the New Zealand construction industry, its contribution to the New Zealand economy and its special characteristics that might be used to leverage improved economic output.

- The construction industry suffers from poor image, poor commercial and financial performance, and perceived lack of integrity. Whilst not generalised, these problems have been caused by fragmentation of the industry, and lack of customer and quality focus.
- The construction industry contributed 4.2% of GDP for the year ending March 2003. Building and Civil Engineering accounts for up to 10.5% of total finished good and services produced in New Zealand.
- The construction industry employs roughly 135,000 people, or about 7% of the total workforce, directly. It is estimated that at least the same number of people are employed on off site work.
- Local studies have shown that a 10% efficiency gain in the construction industry would theoretically lead to a 1.01% increase (approximately $1 billion) in real GDP, 1.44% increase in exports, 0.49% increase in imports, and lower overall consumer prices by 1.59%.
- There are additional significant macroeconomic effects: for every dollar spent in construction gross output, studies show that at least another $1.168 will be generated in other industries, such as the supply of concrete, steel and wood products. Residential building construction is rated as the highest industrial sector to generate multiplier effects. Thus, the healthier the construction industry, the better off the economy as a whole.
- Comparisons with 11 OECD countries show that developed countries invest roughly between 15% and 26% of total finished goods and services produced in Gross Fixed Capital Formation (GFCF). Approximately half of GFCF consists of the construction of buildings and civil engineering i.e. 7% to 11% of total finished goods and services produced in New Zealand.
- In comparison with other industries, little attention is paid to the well being of the construction industry. Government and businesses have not actively supported research and development in construction. That which does take place is generally informal within project teams and remains unrecorded.
- Results from the UK's Constructing Excellence and Australia's Construction Innovation programme show that significant improvements in economic performance can be achieved through innovation in construction. The drivers of change for better project delivery are: committed leadership, customer focus, process and team integration, quality driven agenda, and commitment to people.
- When results from Constructing Excellence's four year average performance improvement are applied to New Zealand's construction industry, it shows that New Zealand has the potential to save at least $593 million over three performance areas. Combined with multiplier effects, there is a potential $1.3 billion to be injected into the economy.

Acknowledgements

The author would like to thank: Dr George Hooper, Executive Director of Centre for Advanced Engineering and project sponsor; Dr Jason Le Masurier, Senior Lecturer for Construction Management at the University of Canterbury and project supervisor; and Ernesto Henriod, Programme Chairman for the Centre of Advanced Engineering for their kind efforts in supporting the author throughout his course of research, and Mr Stephen Hickson for reviewing Chapter 3.

Table of Contents

Glossary

The definitions below apply to keywords that have been used throughout this report:

- *Dollars ($)*: All dollar values are expressed in terms of current prices, unless indicated otherwise. Most current dollars used in this report are expressed in March 2003 figures.
- *Gross Fixed Capital Formation*: The outlays of producers of durable real assets, such as buildings, motor vehicles, plant and machinery, roading, and land improvements. In measuring the outlays, sales of repeated goods are deducted. Land is excluded from gross fixed capital formation. Included is the value of construction work done by a firm's own employees. The term 'gross' indicates that consumption of fixed capital has not been deducted from the value of the outlays. (Source: Statistics New Zealand Website)
- *Residential buildings*: When more than half of the floor area of the building is intended for dwelling purposes, i.e. private habitation. Examples include houses and apartments.
- *Non-residential buildings*: All buildings not classified as residential. Thus can be commercial or non commercial. Examples include hostels, motels, hospitals, schools, shops, restaurants, offices, and storage buildings.
- *Other construction*: Construction projects not predominantly involving the erection of buildings. Examples include dams, runways, and bridges. These will be classified as "Civil Engineering" in this report.
- *Commercial buildings*: Includes shops, restaurants, offices, hotels, motels, doctors' rooms and apartments.
- *Industrial buildings*: Includes warehouses, factories, service stations, substations, maintenance buildings, abattoirs, coldstores, workshops, farm buildings, retaining walls, and bridges.
- *Community buildings*: Includes schools, public and private hospitals, libraries, and halls, social and sports clubs, hostels, boarding houses, rest homes, churches, public toilets, and changing rooms.

Note the overlap in definition between residential, non-residential, and civil engineering; and commercial, industrial and community buildings.

1 Introduction

New Zealand's built infrastructure underpins this country's economic activity. The transportation network enables people to be mobile; housing and buildings give people their living and work space; and water supply, and sewage and refuse disposal systems support a healthy lifestyle. All New Zealanders benefit from a robust and cost effective built infrastructure. The main contributor to infrastructure development and maintenance is the construction industry.

New Zealand construction activity is concentrated and location specific. The Auckland region alone accounts for around half of all construction value in New Zealand based on building consents issued, dominated by residential building activity. The importance of the construction industry in the overall economic performance of a country has been acknowledged internationally, but as yet not in New Zealand. A review of construction industry statistics and opinion shows that there are major issues related to profitability and cost efficiency and that New Zealand is not achieving international levels of best practice. There is significant concern amongst industry participants at the overall performance of the sector and a view that New Zealand could do better. In particular, it is felt that the adoption of improved practices in procurement and delivery of construction could lead to benefits at both the national and enterprise level.

The purpose of this research paper is to:

1. establish the contribution of the construction industry to the New Zealand economy;
2. show evidence of improvements that have been made elsewhere through construction best practice programmes;
3. identify and characterise the nature of research and improvements in the construction sector currently being undertaken in the New Zealand industry; and
4. identify the drivers of change.

By providing insights into the needs of the sectors and what drives change, the Centre for Advanced Engineering (CAE) intends that this report will assist in bringing about improvements in the procurement and delivery of New Zealand's built infrastructure.

1.1 About the Research Project

This research forms part of the author's Master of Engineering Management (MEM) degree requirements. It is funded by CAE and the Foundation for Research, Science & Technology on behalf of the Ministry of Education. The project period is six months and closely supervised under CAE's executive director, Dr George Hooper, and University of Canterbury's Dr Jason Le Masurier.

In producing this research paper, the author has carried out literature reviews, case studies and interviews with industry players. The work programme, meetings and personnel key to this research project can be found in Appendix 1.

2 Underlying Challenges from Historical Culture

In this research study, a series of interviews were conducted with a number of industry players. This research confirms the informal view expressed by many that the New Zealand construction industry suffers similar problems to those faced by other construction industries internationally. Although these problems have mitigated over time, some still persist:

1 Poor image of the construction industry

People view the construction industry as dirty, dangerous and old fashioned. Stories about dangerous construction practices and accidents can often be found in the media. This negative perception makes the industry less appealing to the younger generations who are critical to the supply of personnel for the sustainability of this important sector.

2 Poor commercial and financial performance

Many of the major players such as contractors, subcontractors, suppliers and consultants operate on small profit margins, and are thus are restricted in their capability to reinvest back into capacity building within the sector. Aggressive competitive behaviour within the sector exacerbates this issue, which can often be reflected in costly disputes. Unforeseen work variations, which are common in construction projects, can create a financial burden to any one of the stakeholders.

3 Integrity of the industry

Some tendering processes are perceived as not professional, not transparent and not fair. In the execution of some construction projects, there can be a lack of trust and cooperation. This can lead to communication problems, which will have adverse effects for all stakeholders.

4 Fragmentation of the industry

The construction industry is highly fragmented, with many parties involved in different phases of a construction project. This creates a problem where each party makes or tries to influence a decision in their own interest. Once again, this often leads to disputes and conflict to the detriment of overall performance.

5 Lack of client and quality orientation

The construction process is focused internally on sub-project optimisation rather than the whole life cycle. The lack of systemic thinking and life cycle programme optimisation has been a major barrier to innovation.

6 Imperfect market functioning

Awarding tenders based on lowest price is always a problem. Clients that do not weigh tenders based on quality and value, pressure contractors to “cut corners”, leading to under-resourcing. An emphasis on cost minimisation has been a great barrier to construction innovation. Such clients fail to differentiate between value, price and cost (see Figure 1).

Rather than focussing on price, which is the sum of the costs plus profit, clients should be focusing, for instance, on the quality underlying a tender. The lowest priced tender does not necessarily reflect value to the client. By understanding value and engaging with suppliers in the project procurement phase, better outcomes can be expected.

According to a survey conducted by PriceWaterhouseCoopers[1] of the Australian building and construction

[1] Innovation in the Australian Building and Construction Industry – Survey Results, PWC, 2002

industry, highly innovative companies:

- recorded improvements of 3 to 4 times the proportion of turnover from products and services developed in the last three years;
- recorded improvements of 3 to 4 times the cost savings as a result of process and organisational innovations in the previous three years;
- created more jobs and capitalised on more new markets;
- were 50% less likely to miss their project delivery deadlines; and
- were 50% less likely to fail to achieve their stakeholders' objectives on projects.

The author argues that the above points are a value proposition. Awarding contracts and procuring construction services on the basis of value offers savings and advantages to all participants in the value chain.

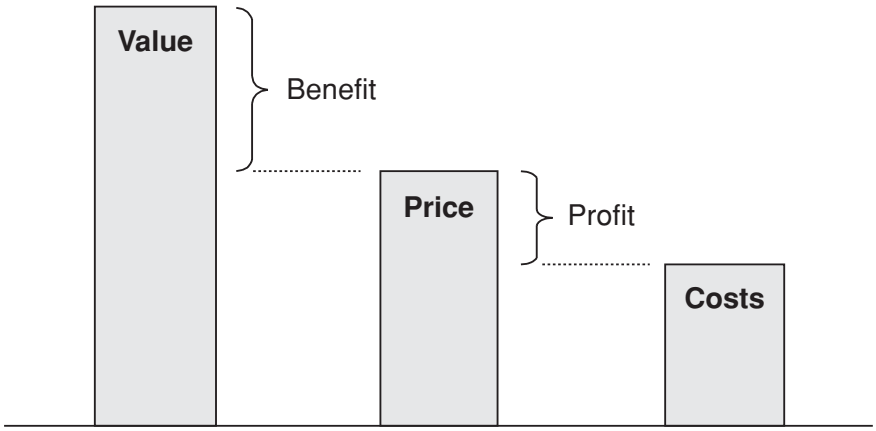


Figure 1: Model showing the difference between value, price and costs

3 Contribution of the Construction Sector to the New Zealand Economy

Information in this chapter takes Statistics New Zealand data and seeks to interpret these data as a basis for quantification of the total contribution that the construction sector makes to the New Zealand economy. Official statistics tend to understate the real value generated by the sector and limit the construction sector to the value-added activity of firms that construct buildings and infrastructure plus those who install construction sub-systems (electrical works, plumbing, air systems, structure, finishing, etc.). This is a very limited approach.

The construction industry covers a wide range of business sectors. Participants in the industry include, but not limited, to:

- Major civil engineering companies (focusing on road, rail, ports, airports, coastal defence, water supply, electricity generation and distribution);
- Major construction companies (typically focusing on substantial commercial housing developments);
- Small and medium sized building companies (tending to work on individual dwellings and small multi-unit developments);
- Developers (who typically commission housing developments for on sale or rental to consumers);
- Designers (architects, engineers, draughtsmen, designers etc) and other professions (project managers, quantity surveyors, etc);
- Small businesses and individual contractors, including specialist occupations (such as electricians, plumbers, etc);
- Skilled labour (trained carpenters, roofers, plasterers, plumbers, electricians, etc);
- Unskilled labour;
- Consumers (commissioners or purchasers of dwellings);
- Product manufacturers and suppliers (plant and machinery, concrete, steel and timber);
- Research institutions;
- Building certifiers;
- The regulators (BIA and TAs);
- Lawyers; and
- Insurers.

The official published figure for the contribution of the construction industry to New Zealand's Gross Domestic Product (GDP) for the year ending March 2003[2] is 4.2% or $4.7 billion at constant prices (current GDP prices were not available at the time of writing). The Statistics department calculates this based on the production approach, which tallies the value of new buildings (e.g. houses, offices, shops) and structures (dams, bridges) constructed that year. Such figures, however, do not give the 'big picture' of the contribution made by the sector.

The first point to note is the production approach only takes into account construction activity carried out by companies primarily involved in construction. There are other industries, such as manufacturing, forestry and agriculture, which carry out their own construction activity, which is not recorded. Minor maintenance and renovation works, which do not require building consents, also escape the value recorded by official statistics.

[2] Statistics NZ 2003 GDP Q3 release (Chain volume series, actual, production)

The second point to note is that there are a lot of support services associated with the construction industry. Some of the supporting companies such as steel structure manufacturers, quarries, cement manufacturers, project management services, engineering consultants, and plant services would not be in business if it were not for the construction industry. There are also non construction specific companies that deal with the industry such as insurance, legal and financial services. The problem that thus needs to be addressed in developing a view of the contribution of the sector is how to define these inputs. Direct inputs can be accounted for by measuring the construction industry in terms of expenditure.

Thus, another approach to determining GDP is the expenditure approach. The expenditure approach of measuring GDP is based as far as possible on the prices at which the final goods and services are actually sold in the market place. This approach gives a better view of the industry in terms of value invested in capital goods. New Zealand's investment in buildings and civil engineering works amounted to $13.5 billion ($11.8 billion constant 1995/96 prices) for the year ending March 2003[3]. This value represented 10.5% of the total for final goods and services produced in New Zealand, and consists of investment in residential and non-residential buildings, and other construction (excluding land improvements).

Key differences in the Production Approach and the Expenditure Approach

There is ambiguity and confusion when stating the contribution of the construction industry to the economy. The media usually publishes either 4.2% (based on the production approach) or 10.5% (based on the expenditure approach).

In true economic definition, 4.2% should be used because the production approach is used by default when comparing an output to the total GDP. Although technically correct, the production approach does not define the size of the industry because the total value added is calculated by taking the difference between the total gross output (i.e. final cost of a particular building) and the intermediate consumption (i.e. raw materials of that particular building). Therefore, what this approach is accounting for is the compensation of employees (labour costs), operating surplus (profit earned), consumed fixed capital (depreciation), and any indirect taxes and subsidies. Most would argue that this would not be the ideal method to describe the industry, but this is the most widely used approach to GDP calculation, and involves all major industries for comparisons.

The expenditure approach is a better method to describe the size of the industry because it measures the gross output of production (i.e. the final selling price). Care must be taken not to express this output value as a percentage of GDP because it is misleading. As mentioned previously, the default method when expressing a percentage of total GDP is the production approach. The expenditure approach measures the value of production of *final* goods and services. Therefore stating construction contributes 10.5% of GDP is misleading because we are comparing buildings (completed goods) with other completely assembled products, such as cars. All intermediate goods manufacturers, such as steel and tyre manufacturers would not have been included as an "industry" in the expenditure approach definition because that would be double counting.

Statistics New Zealand defines total gross fixed capital formation (GFCF) as the sum of investments in:

- residential buildings
- non residential buildings
- civil engineering
- land improvements
- transport equipment

[3] Statistics NZ 2003 GDP Q3 release (Current/chain volumes series, actual, expenditure)

- plant and machinery
- intangible assets

For the year ending March 2003 total GFCF investments were $25.5 billion[4], where slightly more than half was invested in buildings and construction ($13.5 billion mentioned earlier). Figure 2 shows the level of New Zealand's GFCF and construction investment over the last 15 years. These numbers were derived by dividing the expenditure for final fixed capital by total final goods and services produced in New Zealand (i.e. the expenditure approach). As can be seen, New Zealand spends between 7.8% to 11.5% of final good and services expenditure on construction activity, which makes up 46.1% to 55.2% of total investments on GFCF. The other components on top of buildings and civil engineering to make up total GFCF are investments in land improvements, transport equipment, plant and machinery, and intangible assets.

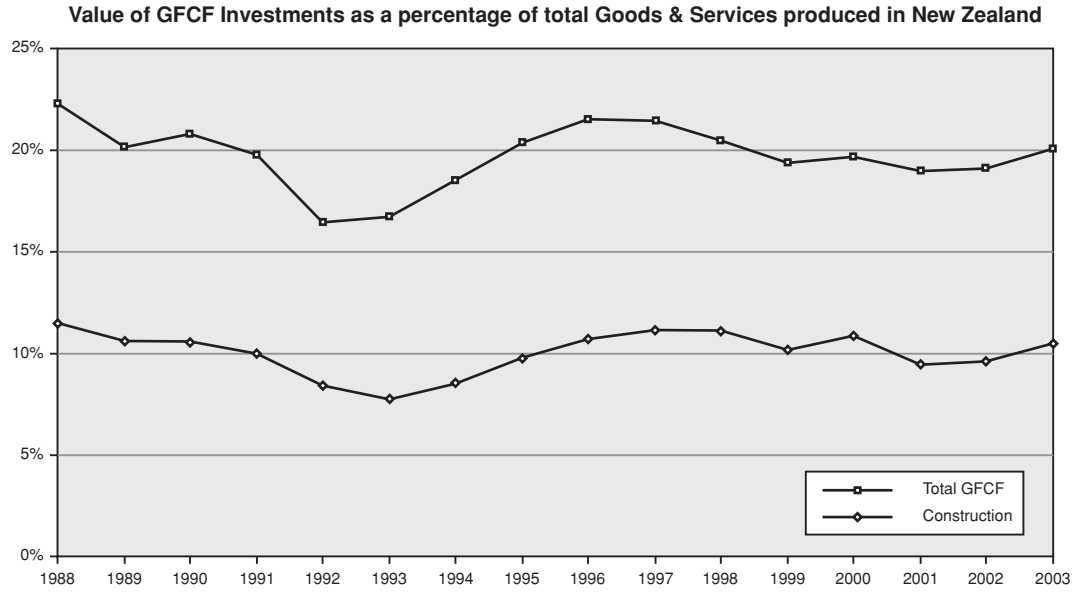


Figure 2: Historical series of New Zealand's capital investment

Without assessing in depth the implications of the level of capital formation, sufficient GFCF is clearly very significant to a nation's socioeconomic well being. Comparisons against other economies (Chapter 5) reinforce the relative importance of construction to the New Zealand economy.

Figure 3 shows the historical trend in capital allocation. The increase in construction fixed capital investments in the last year was largely driven by a strong demand in residential buildings[5]. Residential buildings continue to dominate construction statistics. With planned new investments in major infrastructure works over the next several years (such as the Auckland Eastern Corridor), this distribution could well change and again reinforces the importance of innovation and performance to the New Zealand economy (see PWC survey results on page 10).

Another important indicator of the economic contribution is the level of employment within the sector. Statistics[6] show that the construction industry employs roughly 138,700 people, or about 7.2% of the total workforce per quarter in 2003. These figures only account for the people working on site and do not include the off-site services such as design, finance, materials production and supply. It is estimated[7] that the off-site services employ at least the same number of jobs as on-site work, making the industry a significant employer of the New Zealand workforce.

[4] Statistics NZ 2003 GDP Q3 release (Current, actual, expenditure)

[5] Statistics NZ 2003 GDP Q3 release (Chain volume series, actual, expenditure)

[6] Statistics NZ 2003 Household Labour Force Survey Q4 release

[7] Page, I. , Build Dec 2003/Jan 2004 p46, BRANZ

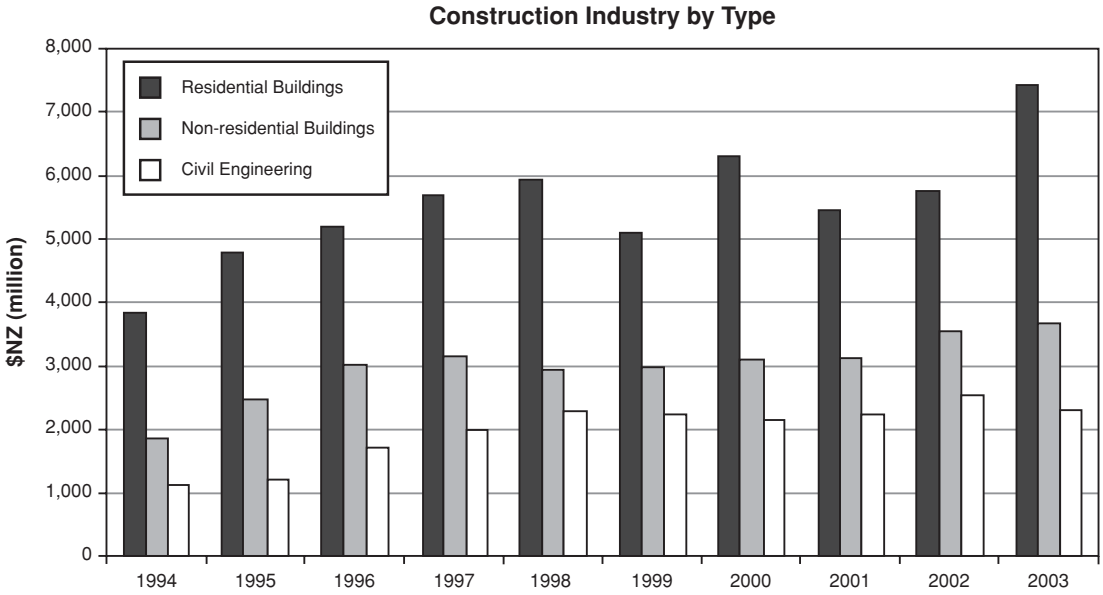


Figure 3: Historical series of New Zealand Building types in Current Dollars

In comparison, other large sectors of employment are wholesale and retail trade, which employs on average 442,400 people; and the manufacturing sector, which employs on average 278,800 people. It is worth reflecting on the types of multiplier that derive from major works. During major construction works, the productivity and efficiency of the New Zealand workforce, and thus the total New Zealand content, will have a direct impact on multiplier effects. This is an area that is perhaps worthy of further study.

3.1 Summary and Conclusions

- The construction industry directly contributes 4.2% of the value added to GDP (production approach).
- The value of the final assets produced by construction activity (all parties undertaking construction activity whether included in the construction industry or not e.g. manufacturing) is 10.5% of all final goods and services produced in New Zealand (expenditure approach).
- For the year ending March 2003, GFCF made up 20.0% to total GDP expenditure ($25.5 billion), where more than half of it consisted of buildings and civil engineering work ($13.5 billion)
- The construction industry directly employs roughly 138,700 people on site. This is equivalent to 7.2% of the total workforce. It is estimated that off-site services employ at least the same number of personnel which together would account for at least 14% of the New Zealand workforce.
- Further work to examine the implications of improved productivity and efficiency through the multiplier effect from major construction projects is recommended.

4 Macroeconomic Effects of Efficiency Gains in Construction Activity

A report[8] published by the Building Research Association of New Zealand (BRANZ) in 2003 using 2001/02 data shows that a 10% efficiency gain in the construction sector (residential and non residential buildings, and civil engineering) would theoretically result in a 1.01% (at least $1 billion) increase in real GDP. Efficiency gain is defined as achieving increased output from existing inputs of labour and physical capital resources, or achieving the same level of output with less labour and capital invested. Besides an increase in real GDP, the 10% efficiency gain was estimated to increase exports and imports by 1.44% and 0.49% respectively, and lower overall consumer prices by 1.59%. This analysis was done by BERL modelling the New Zealand economy with a general equilibrium model called JOANNA. This work is the third in a series of reports commissioned by BRANZ regarding the efficiency of the construction industry.

The building and construction sector was ranked eighth against other industries in terms of potential to benefit the economy from improved efficiency. This is a remarkable potential contribution considering that new buildings and construction make up only 4% of GDP.

The same report also found high interactions from the construction industry with the rest of the economy. What this means is that there are many industries that are directly related to the construction industry, such as wood processing, metal manufacturing, plumbing services and wholesale trades. Residential, non-residential, and civil engineering construction ranked 1st, 5th, and 7th respectively as industries that have the highest direct and indirect gross output multiplier (see Table 1). Direct and indirect gross output multiplier refers to the impact of each industry's demands for materials and products from other industries used as inputs in further processing or manufacture within their own industry, which is also referred to as demands for intermediate inputs.

The direct and indirect gross output multiplier for building and constructions are shown in Table 1.

Industry	Direct and Indirect Gross Output Multiplier	Rank
Residential Buildings	2.632	1
Non-residential Buildings	2.211	5
Civil Engineering	2.168	7

Table 1: Findings from Nana's report in 2003

This reinforces the anecdotal experience of the flow-on effects to the wider economy from construction activity. What the above multiplier means is that, in the case of residential buildings, every dollar of gross output in the residential building industry results in another $1.632 worth of gross output from related

> "The Joanna model separately identifies 51 different industries, capturing their inter-industry relationships (both as purchasers and sellers, supported by Statistics New Zealand), their labour and capital requirements, within the standard neo-classical framework of cost-minimising producers and 'utility' maximising consumers responding to relative price shifts. All these interactions, including behaviour of households, firms and government, and the linkages between the various sectors in the economy, are described by several thousands of mathematical equations. This in effect, creates a 'balancing act' between supplies of and demands for various commodities and production factors. The analysis approach used assumes all other exogenous variables remain unchanged (referred to as the ceteris paribus assumption); and that changes to the economy, as a result of efficiency gains, are made when the economy has returned to equilibrium." [9]

[8] Nana, G, *Assessment of the Economic Impact of Efficiency Improvements in Building and Construction*, BERL, August 2003

[9] 'The JOANNA Model' by Nana 1983

industries such as the supply of metal and wood, and transportation. All three construction components have multipliers higher than 2, which influence the collective output of other industries by more than 100%. These findings show that the healthier the construction industry is, the better off the economy as a whole from the flow-on effects.

A 10% efficiency gain is achievable based on evidence from the UK. IFor example, companies applying tools and techniques from the Construction Lean Improvement Programme (CLIP) have regularly achieved productivity improvement in excess of 20%[10]. Within the Movement for Innovation (M4I) programme for the fourth year running, demonstration projects have shown, on average:

- construction costs 6% lower than the industry average;
- accident rates 61% lower than the industry average; and
- profit margins 2% higher than the industry average.

The potential savings the New Zealand industry could make based on the UK's Constructing Excellence four-year average results, should one third of the industry take up best practice, is equivalent to a 4.4% ($593 million) efficiency gain (see Section 9.1, Table 6). The efficiency gain would inject at least another $712 million into the economy because of the multiplier effect from Nana's findings.

Unlike in the UK and other overseas sectors, there have been no published studies defining the current efficiency of the New Zealand construction industry. Although there are no exact figures on the room for improvement, businesses agree that the industry is not performing at its optimum and there is a lot more they can do to improve efficiency and productivity.

4.1 Summary and Conclusions

- A study on the impact of a 10% efficiency gain in the construction sector shows that New Zealand could benefit from increases of 1.01% in real GDP, 1.44% in exports and 0.49 in imports, and a decrease of 1.59% in overall consumer prices
- Residential buildings, non residential, and civil engineering had direct and indirect gross output multipliers of approximately 2.6, 2.2 and 2.2 respectively. These values mean that every dollar of output in the construction industry will generate at least another 120% worth of output in a related industry. On this basis, and from the analysis carried out in Section 9.1 Table 6, a potential $593 million extra output would inject at least $712 million into the economy. Residential construction has the highest multiplier effect of any industry.
- An average of 4.4% cost savings was achieved in only three areas (cost, safety, and profitability) by the UK's Constructing Excellence programme. There are other tangible and intangible factors such as better work productivity and faster construction time that will make a 10% efficiency gain target achievable.
- There is a lack of published studies and research on the operating efficiency of the New Zealand construction industry. Studies are needed to establish the current operating efficiency and the room for improvement in the current industry environment, which would need the support of industry and government.

[10] Construction Lean Improvement Programme webpage

5 International Comparisons of Construction Capital Expenditure

Based on OECD data[11] (current Sept 2002), the construction component of gross fixed capital formation (GFCF) as a percentage of GDP Expenditure is shown below (see Table 2). The results ranged from 7.1% to 11.1% for New Zealand, Australia, USA, Japan, UK, Canada, Switzerland, Sweden, France, Germany, and Italy. Total GFCF, which includes both construction and machinery, ranged from 17.2% to % 25.2%.

	NZ ('000)	**UK (GBP '000)**	**Australia (AUD '000)**	**USA ($bil)**
	Jun-02	Jun-02	Jun-02	Jun-02
GDP Expenditure	28220	214215	176106	2348.1
GFCF	5820	36772	41487	474.5
GFCF-machinery		21493	11966	280.6
GFCF-construction	2748*	15279	16405	196.1
GFCF/GDP Exp.	**20.6%**	**17.2%**	**23.6%**	**20.2%**
Const./GDP Exp.	**9.7%***	**7.1%**	**9.3%**	**8.4%**
	Canada (CAD '000)	**Japan (JPY min)**	**Germany (EUR min)**	**Italy (EUR min)**
	Jun-02	Jun-02	Jun-02	Jun-02
GDP Expenditure	264621.5	133493	496.375	258.3
GFCF	53606.25	33648.5	97.725	52.35
GFCF-machinery	24037		44.55	30.225
GFCF-construction	29487.75		53.175	22.075
GFCF/GDP Exp.	**20.3%**	**25.2%**	**19.7%**	**20.3%**
Const./GDP Exp.	**11.1%**		**10.7%**	**8.5%**
	France (EUR min)	**Sweden (SEK '000)**	**Switzerland (CHF '000)**	
	Jun-02	Jun-02	Jun-02	
GDP Expenditure	348.1	548544	87076.75	
GFCF	71.7	95705	20516	
GFCF-machinery	41.55			
GFCF-construction	29.875			
GFCF/GDP Exp.	**20.6%**	**17.4%**	**23.6%**	
Const./GDP Exp.	**8.6%**			

Table 2: Official National Quarterly Economic Information

As can be seen, New Zealand investment in capital formation is comparable to average OECD values. These countries have realised that nearly one tenth of their country's GDP value is tied up with construction investments, and that significant value can be generated from innovation and improved construction processes from project procurement to delivery. Developing research centres for construction innovation and transferring that knowledge to the industry is a step forward to increasing the overall performance of the construction industry.

New Zealand is not taking this forward step and this is evident when looking at local expenditure on research and development (see following chapter).

[11] OECD data from the Australian Bureau of Statistics. Figures seasonally adjusted and in constant currencies.

6 Research and Development Expenditure in New Zealand and Overseas

Although New Zealand invests as much into capital expenditure on infrastructure as most other OECD countries, an OECD report published with 2001 data showed that New Zealand spends less than half of the OECD average (in terms of gross expenditure) on R&D as a percentage of GDP (see Appendix 3).

This investment gap has not narrowed in recent years. Although the exact figure of R&D expenditure for construction in each country is not available in this report, Chapter 7 contains some funding information for selected overseas construction innovation programmes.

A survey of 46 firms done in August 2002 by the Ministry of Research, Science & Technology[12] (MoRST) showed that New Zealand is severely lagging behind OECD countries in terms of R&D carried out by private businesses (see Figure 4). Whilst one could argue this is a limited survey, the numbers show the relative contribution to R&D in construction lags way behind other industries. Business expenditure on construction-related R&D only measured a mere 0.4% of total research expenditure ($2.1 million). In comparison, 56% of total business expenditure on R&D was spent by the manufacturing sector. The R&D expenditure for the three highest manufacturing sectors were machinery and equipment manufacturing ($107.7 million); petroleum, coal, chemical and associated product manufacturing ($79.3 million); and food, beverage and tobacco manufacturing ($67.8 million).

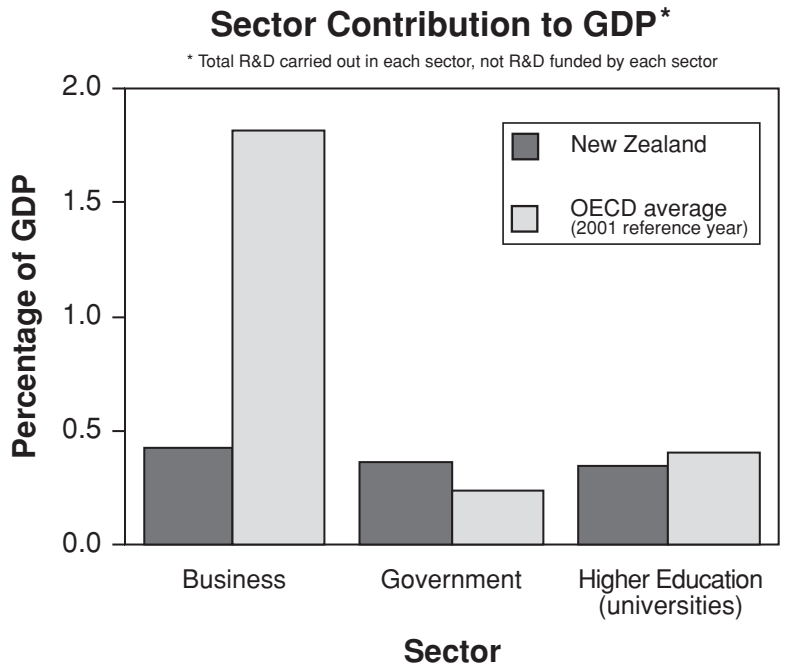


Figure 4: Chart shows difference in support among businesses in NZ and other OECD countries (Reproduced from Research and Development in New Zealand 2002)[12]

Business R&D expenditure in construction is very little compared to the manufacturing sector. Table 3 below shows that construction activity creates more value added compared to petroleum, coal, chemical and associated manufacturing, and machinery and equipment manufacturing, but the expenditure on business R&D is significantly less.

A possible reason for the low level of research and development carried out could be the general reluctance of NZ businesses to invest in R&D. Figure 5 shows the breakdown of NZ funding for R&D. Private

[12] Research and Development in New Zealand 2002, MoRST & Statistics NZ

Industry	2002 NZ Business R&D Expenditure (% of total expenditure)	2002 GDP contribution[13] (production approach) (% of GDP)
Construction	$2.1 million (0.4%)	$4.2 billion (3.9%)
Food, beverage and tobacco manufacturing	$67.8 million (12.9%)	$5.2 billion (4.8%)
Petroleum, coal, chemical and associated product manufacturing	$79.3 million (15.1%)	$1.9 billion (1.8%)
Machinery and equipment manufacturing	$107.7 million (20.6%)	$2.4 billion (2.2%)

Table 3: The amount of R&D invested compared with industry contribution to GDP

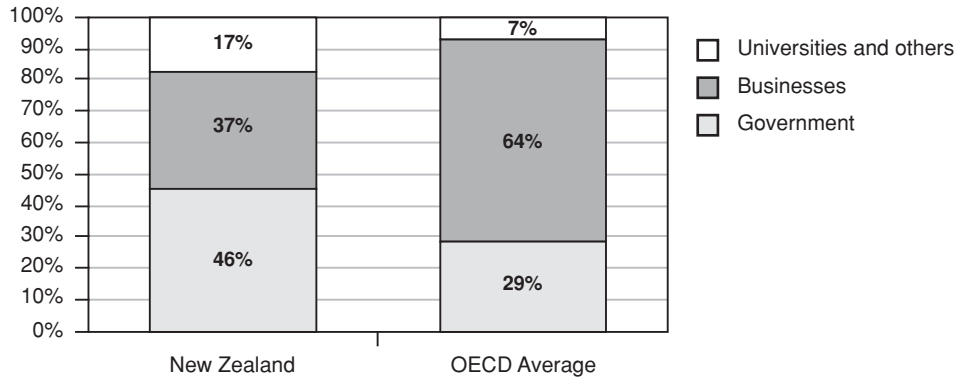


Figure 5: Different components of funding in New Zealand and overseas

businesses are not contributing as much as they do in most other OECD countries.

There were no specific data published in the MoRST survey results regarding construction related R&D carried out by higher education institutes in New Zealand. The report grouped construction R&D together with materials, electronics and engineering to come up with 4% of total higher education R&D expenditure, which collectively amounts to $17.5 million. The three key areas higher education institutes invested in R&D were the general advancement of knowledge ($143 million); health ($93 million); and social development and services ($58 million).

Increasing investment in R&D alone is not enough if the construction industry does not **innovate**. A definition of innovation is given in the PriceWaterhouseCoopers report[14] as:

> *"developing new products, services, processes, technologies and markets"*

In this respect, New Zealand lags behind other leading countries including Australia, United Kingdom, France, Spain, Germany and the United States.

Although studies[14] have shown that there is no direct relationship between "innovativeness" and business R&D expenditure, what R&D funding does is to promote innovation when funds are channelled through the right resources. Groak[15] (1992) points out that despite the low level of formal expenditure on research, the industry possesses many innovative characteristics because of the constantly changing nature of the end product. Much of this innovative behaviour and associated research takes place on site, on the drawing board, or in more informal social settings. As such it remains unrecorded, under evalu-

[13] Statistics NZ 2003 GDP Q3 release (Chain volume series, actual, production)

[14] Innovation in the Australian Building and Construction Industry – Survey Results, PWC, 2002

[15] Groak, S. *The Idea of Building*, E&FN Spon, 1992.

ated, but more importantly, not recovered for widespread acknowledgement and use by the industry.

Overseas, construction institutions funded by governments and industry, have set up innovation and best practice programmes to help their local construction industry achieve more efficiency through innovation. They act as research and development centres that collate, process and disseminate information such as best practice examples, benchmarking results, and case studies. The establishment of such centres creates an innovative environment where the industry is constantly challenged to perform better, thus improving the performance of the industry as a whole.

6.1 Summary and Conclusions

- Total gross expenditure on R&D in New Zealand lags behind most other OECD countries.
- New Zealand businesses are not investing in and carrying out as much R&D compared to most other OECD countries.
- Business R&D is focused primarily on the manufacturing sector. This level of investment does not correspond to its proportional contribution to GDP. Construction creates more value-added (3.9%) compared with machinery and equipment manufacturing (2.2%), and petroleum, coal, chemical and associated product manufacturing (1.8%), but receives a lot less business R&D funding.
- The lack of construction R&D in tertiary institutions appears to result from the low interest in this field of study.
- Much of construction innovative behaviour and associated research takes place in informal settings in which information is unrecorded, under evaluated, and not recovered for widespread acknowledgement and use by the industry.

7 Construction Innovation Programmes Overseas

It is important to distinguish between building research programmes and construction innovation programmes. Most building research programmes focus on building products and materials, whereas innovation programmes are process-oriented and have a project management focus. There are building research centres in many countries, but innovation programmes are confined to developed countries. The construction innovation programmes overleaf are some that have been identified. They are described in more detail in the sections that follow:

7.1 Australia: Cooperative Research Centre for Construction Innovation

The Cooperative Research Centre for Construction Innovation (CRC-CI) is a national research, development and implementation centre focused on the needs of the property, design, construction and facility management sectors. The programme involves nineteen industry, government and research partners and is centred in Brisbane.

Construction Innovation aims to develop key technologies, tools and management systems to improve the effectiveness of the construction industry. The three research programs currently available are: business and industry development; sustainable built assets; and delivery and management of built assets. Construction Innovation disseminates information through texts, seminars, and conferences. It has also aligned itself with the vocational education and training sector and associations such as Construction Training Australia in efforts to increase the construction industry's uptake of research outcomes.

Funding: AU$14 million Federal Government grant through the CRC Program complemented by AU$50 million of cash and in kind support from industry, research and other government partners.

7.2 United Kingdom: Constructing Excellence

Constructing Excellence (CE) is the banner under which the construction industry, its clients and the government are working together to improve UK construction performance. It brings together the two unique construction programmes, Rethinking Construction and Construction Best Practice, which hosts the Central Government Task Force, the Housing Forum, the IT Construction Best Practice programme, the Movement for Innovation programme, the Respect for People Working Group and the Building Services Best Practice programme.

Constructing Excellence consists of four key parts: innovation, productivity, best practice knowledge, and industry engagement. Programme partners aim to showcase innovations in both products and performance through Demonstration Projects and highlight best practice available within the industry. The value of demonstration projects totalled up to 7 billion pounds in 2002, making up to 10% of the entire industry by value. CE also seeks to encourage a greater degree of co-operation between the industry and its clients to adopt the best practice principles to their mutual benefit. Besides sharing innovative solutions, the Constructing Excellence programme also publishes generic benchmarking data from its supporting programmes. These data are used as a reference for comparison and target setting, which is intended to improve the performance of the building and construction industry.

7.3 USA: Lean Construction Institute

The Lean Construction Institute (LCI) is a non-profit corporation that carries out research in developing knowledge on project based production management in the design, engineering, and construction of capital facilities. Contributors to LCI carry out research in this and related fields, participate in regular research meetings and implementation meetings. Research falls within three categories: production theory, the production system, and organisational change.

LCI conducts its own research and also funds research by others. Research findings will not be made public until one year after members have received the subject report at which time findings will be

Country	Programme name	Description	Core Areas	Funding - Government	Funding – Other
Australia	CRC Construction Innovation (CRC-CI)	Brings together researchers from universities, government bodies, and private industry and public sector agencies, in long term collaborative arrangements which support R&D in construction	Business and industry development; sustainable built assets; delivery and management of built assets	AU$ 14 million over 7 years	AU$ 50 million in cash and in kind over 7 years
United Kingdom	Constructing Excellence (CE)	Largest construction programme in the UK which hosts benchmarking exercises, demonstration projects, and disseminates best practice knowledge.	Innovation; productivity; best practice knowledge; industry engagement	£4.5m per year	£4m per year
USA	Lean Construction Institute (LCI)	Conducts and hosts research on project based production management in the design, engineering and construction of capital facilities	Production theory; production systems; organisational change		
Netherlands	Process and System Innovation in the Construction Industry (PSIB)	Brings together the major stakeholders in the Dutch construction industry and act as a knowledge centre by drawing knowledge from existing local "satellites" and similar programmes internationally	Demand process innovation; transaction process innovation; supply process innovation	56.7 million Euros from 2003 to 2007	
Sweden	Competitive Building (CB)	Builds a link between Sweden's building sector and its universities. Practical research is conducted based on an individual company which can be applied to the industry at large	Industrialised building for good living; rationalised real estate redevelopment	4.1 million Euros over 5 years	4 million Euros from various sources over 5 years
Finland	The National Technology Agency of Finland (TEKES)	Funds short and long term programmes over a variety of research areas, including construction. The ProBuild programme was a 5 year programme focused on the building process, end products and project life cycle	Building owners' needs & requirements; procurement methods for project management, design & construction; implementation of design & construction; building processes & quality	ProBuild programme only - FIM 80 million from 1997 to 2001	
Hong Kong	Provisional Construction Industry Co-ordination Board (PCICB)	Serves as a link between owners, industry and research groups to promote collaborative research on real and practical issues. Also functions as a primary channel for Government to seek industry's feedback regarding related policy issues	Construction cost & performance indicators; construction site safety & employers' compensation insurance; management of subcontracting, manpower training & development; formation of the statutory industry co-ordination board		

Table 4 Selected international construction innovation programmes Australia: Cooperative Research Centre for Construction Innovation

disseminated through publication in academic journals, industry presentations, and LCI seminars.

Funding: Funding for LCI research comes from member contributions, private contracts, and grants.

7.4 Netherlands: Process and System Innovation in the Construction Industry

Process and System Innovation in the Construction Industry (PSIB) is an initiative that brings together the major stakeholders in the Dutch construction industry: clients, contractors, suppliers, consultants, research institutes and universities, with the aim to modernise the industry through process and system innovation. The construction industry in the Netherlands acknowledges the need for change and PSIB functions to direct this change in cooperation and interaction with the entire construction industry and through contacts with similar international initiatives, with the aim of achieving sustainable improvement in quality, performance and image.

The programme covers a wide area of construction innovation from project procurement to knowledge dissemination. The three innovation areas are demand process innovation; transaction process innovation; and supply process innovation.

Funding: The total PSIB programme budget from 2003 to 2007 is estimated at 56.7 million Euros. Funding allocated for research projects is 30.8 million Euros (averages to 6.2 million Euros per annum).

7.5 Sweden: Competitive Building

Competitive Building (CB) represents a unique partnership between Sweden's building sector and its universities. Industry-aware researchers are recruited to join Competitive Building's competence developing programme to focus on resolving a problem of significance to an individual company, as well as the sector at large. Researchers from the programme are encouraged to apply themselves to the implementation of their research results in the companies with whom they are working. The two general themes of the programme, which are based on market demand, are Industrialised Building for Good Living and Rationalised Real Estate Redevelopment.

The Research School for the Building Sector, which forms a major element in Competitive Building's strategy for research excellence and relevance, regularly brings together the researchers and exposes them to the thinking of leading academics and industrialists. The researchers attend courses of study that provide them with new insights, skills and tools to help them in their work. Competitive Building has now established a community of researchers, creating an active community of research.

Funding: Funding over five years, ending in 2003, totalling 8.1 million Euros was made possible by the Swedish Foundation for Strategic Research (which contributes 4.1 million Euros); the Development Fund of the Swedish Construction Industry; the Swedish Council for Environment, Agricultural Sciences and Spatial Planning; and businesses in the construction industry (collectively contribute the remaining 4 million Euros).

7.6 Finland: The National Technology Agency of Finland

The National Technology Agency of Finland (TEKES) funds short and long term programmes that aid a variety of research areas, including construction. One such programme was "ProBuild" which focuses on the need to improve the building process and its end products while also emphasizing the building's properties over its entire life cycle. The ProBuild programme consists of a series of research areas such as the building owners' needs and requirements; procurement methods for project management, design and construction; implementation of design and construction; and building processes and quality.

Current ongoing programmes include CUBE, the building services technology programme; Infra, the construction and services programme; Rembrand, the real estate management and services programme; and Sara, the value networks in construction programme. The agency is located in Helsinki.

Funding: The overall budget for the ProBuild programme was FIM 80 million (US$ 15 million) for the years 1997 to 2001.

7.7 Hong Kong: Provisional Construction Industry Co-ordination Board

The Provisional Construction Industry Co-ordination Board (PCICB) was established to spearhead industry reforms and to propagate a new culture of change in Hong Kong. It is a pan-industry forum for stakeholders to deliberate and forge consensus on strategic matters as well as to communicate their needs and aspirations to Government. It also functions as a primary channel for Government to seek the industry's feedback on policy issues impacting on local construction. The PCICB established five working groups focusing on construction cost and performance indicators, construction site safety and employees' compensation insurance, management of subcontracting, manpower training and development, and formation of the statutory industry co-ordination board.

Besides the task groups, it incorporates the Construction Industry Institute, a joint initiative founded by 32 members from both industry and the academia. The Institute provides a forum promoting a strategy of collaborative research directed towards real and practical issues. This then serves as a direct link between owners, industry and research groups for the establishment of priorities, approval of research and subsequent flow of benefits. The forum enables members to meet on a regular basis, share experiences of their innovations, learn from others and foster a culture of continuous improvement

7.8 Other Innovation Programmes

Besides those already listed, there are many others such as Denmark's Projekt Hus, France's Chantier 2000, Australia's Evergen and International Construction Research Alliance (ICALL), BouwBeter in the Netherlands and the Construction Industry Development Board, South Africa.

8 Lessons Learnt from International Construction Innovation Programmes

Results from overseas construction innovation programmes show that significant and tangible benefits have been achieved through projects that have applied best practice principles. Savings have resulted from lower construction costs, higher productivity, better profitability, fewer civil actions, fewer defects, fewer accidents, less environmental impacts, and faster construction times. Other intangible benefits include better client satisfaction and government policy influence. The following illustrate the benefits that have resulted from the UK's Constructing Excellence and Australia's Construction Innovation programmes.

8.1 Effectiveness of the UK Constructing Excellence Programme

Results have shown that the Movement for Innovation (M4I) programme, under Constructing Excellence, has enabled its participants to improve their performance when compared to the rest of the industry. Application of best practice principles have rapidly led to:

- Significant improvement in predictability of time and cost;
- Enhanced quality and reduction in defects;
- Marked increases in productivity and profitability;
- Clear evidence that efficiently run design and construction projects are significantly safer and healthier; and
- More repeat business.

Table 5 gives further details on project performance improvements as measured by the programme participants completed in 2002[16]:

These results were achieved through member services such as:

- access to innovative practices being tested on the Demonstration Projects;
- toolkits and guidance documentation to improve efficiency;
- networking with like-minded progressive companies, organisations and individuals, from all parts of the industry; and
- forums that set standards across the industry.

8.2 Effectiveness of the Australian CRC Construction Innovation Programme

As a result of collaborative research amongst industry, government, research centres and education institutions, the following have been reported from the CRC Construction Innovation programme[17]:

- 50% of clients and industry agree that the image and overall stakeholder satisfaction with the industry has improved.
- 10% fewer civil actions against construction firms.
- 10% reduction of industry injury and fatality. As a result of this, worker insurance premiums have reduced by 10%.
- The organisation being accepted as a positive influence on government policy.
- 50% reduction in project time, quality and budget failures.

[16] Constructing Excellence website

[17] CRC Strategic Plan 2003-2008 brochure, June 2003

Headline Key Performance Indicator	Measure	Demonstration Projects	Industry Average	Performance Improvement
Client Satisfaction - Product	scoring 8/10 or better	90%	78%	**15%**
Client Satisfaction - Service	scoring 8/10 or better	86%	71%	**21%**
Defects	scoring 8/10 or better	87%	68%	**28%**
Environmental Impact - Process	scoring 8/10 or better	76%	51%	**49%**
Environmental Impact - Product	scoring 8/10 or better	62%	28%	**121%**
Safety - Project	Accident incidence rate	428	1097	**156%**
Predictability Cost - Design	on target or better	71%	65%	**9%**
Predictability Cost - Construction	on target or better	64%	52%	**23%**
Predictability Time - Design	on target or better	66%	53%	**25%**
Predictability Time - Construction	on target or better	69%	59%	**17%**
Profitability	Median profit before interest & tax	6%	5.80%	**3%**
Productivity	Median value added/employed (£000)	35	31	**13%**
Construction Cost	Change compared with one year ago	-3%	+5%	**8%**
Construction Time	Change compared with one year ago	-2%	+1%	**3%**

Table 5: Performance improvements made possible by the Constructing Excellence Programme

- 10% improvement in project profitability for participants.
- 10% improvement in stakeholder satisfaction.
- 50% reduction of documentation errors by project teams.

8.3 Drivers of change

In order to improve performance in construction procurement and delivery, this section examines the drivers of change as identified through the research undertaken in bringing this report together. Technical knowledge is important, but not all that is necessary to create change in the way projects are delivered. The following are five drivers of change that have been identified by the Constructing Excellence Task Group[18], which are applicable to New Zealand projects:

Committed leadership

All management levels must believe and be totally committed to driving forward an agenda for improvement and communicating the required cultural and operational changes. Leadership, especially from senior management, is an important tool in empowering an organisation. This fact is confirmed in an independent survey by the Property council of Australia[19] on 28 "Excellent" projects, where "Client

[18] Rethinking Construction - The Report of the Construction Task Force, 1998

[19] Projects as Wealth Creators - Drivers of Project Excellence, Property Council of Australia Ltd, 2001

Leadership" was ranked as the top driver of excellence amongst others such as trusting relationships, and open communication.

Customer focus

Successful companies are those who consistently deliver projects to their customers "on time, on budget and on spec". For example, the author has found that the Papatoetoe Undergrounding Project was one such case (see Appendix 4 (a) for the case study). The "dig once" policy reflected the project's core value of providing a service that upgraded the utility services with minimum possible disruption to the public.

Process and team integration

Construction project processes are often a series of sequential and largely separate operations. In order to deliver value to the customer efficiently, the project team need to work back from the customer's needs and focus on the product and the value it delivers to the customer. Integrating the supply chain through partnering or alliancing arrangements is yielding significant benefits to those involved. In one of the demonstration projects, the Auckland Airport Refurbishment Works, partnering between the client and the contractor helped optimise the work programme, which led to the early completion of the project (see Appendix 4 (b) for the case study).

A quality driven agenda

Quality not only means a project delivered with no defects. It includes a product and service handed over right the first time, being within budget and time, innovating for the benefit of the client and reducing waste. Quality means meeting or exceeding the customer's expectations and providing real service throughout the project life cycle. Delivering on such a promise can be challenging when clients award tenders based on lowest price (see discussion of "imperfect market functioning" in Chapter 2). Certainly local government are becoming more aware of this issue through evidence from the establishment of the Local Government Act 2002, whereby local governments have guidelines to help make procurement decisions based on whole-life costing and asset management planning.

Commitment to people

The author believes that more companies in the industry must realise that people are their greatest asset. Failing to recognise this will waste talent and not enable the company to operate at its maximum potential. Companies who make a commitment to their people will train and develop highly capable managers and supervisors, have respect for all participants in the process, and create a working environment based on mutual interdependence and trust. The Grafton Gully Project is a good example of where every employee felt like they were part of the team. The author found out that through this culture, employees had greater work pride and were highly motivated (see Appendix 4 (c) for the case study).

9 New Zealand Improvement Initiatives and their Effectiveness

The construction industry is too important an industry for the government or the economy to ignore. The industry plays a huge role in the economic health, infrastructure development and employment generation for New Zealand. Without continuous improvement, New Zealand construction has and will continue to lag international best practice. Overseas companies who are more efficient and adopt best practice will gradually enter the New Zealand market, causing local companies to lose market share, and ultimately, shareholder value. Multiplex, an Australian company, is an example of penetration into the New Zealand construction market.

The author argues that through construction management and innovation programmes, the local construction industry will become better equipped with the knowledge needed to improve the standards plus gaining the methodologies to be more competitive internationally. Increased international competitiveness not only helps to defend local market position, but also opens opportunities to venture overseas. Being able to export construction services will contribute to the economy as a whole.

9.1 CAE's Initiative

There are currently no programmes in New Zealand that fully meet industry needs. Representation of the sector is channelled through several organisations and informal mechanisms, but none coherently facilitates adoption of best practices. CAE, through its "Best practice in Construction Procurement and Delivery Programme", has set out to fill this gap at least in part, and be at the forefront of innovation for the construction industry.

Conference: "The Contract in Successful Project Management: Innovations in Contract form and Dispute Prevention and Resolution" (February 2002, Christchuch)
Publication: "The Contract in Successful Project Management: Innovations in Contract form and Dispute Prevention and Resolution" (316pp, published September 2002)
Seminar: NEC Partnering - Tamar Bridge Case Study (April 2002, Christchurch)
Seminar: "Project Alliancing" (March 2003, Auckland and Christchurch)
Workshop: "New Engineering Contract" (February/March 2004, Christchurch and Auckland)
Workshop: "Partnering Masterclass" (March 2004, Auckland)
Workshop: "Best Practice in Procurement and Delivery of Construction Services (April 2004, Christchurch and Auckland

Table 6: CAE Initiatives in the Construction Sector

CAE is currently looking at how best to build a broader construction innovation programme from its strategic linkages in the engineering and construction sectors, both nationally and internationally. CAE has currently taken on board several demonstration projects around New Zealand that have adopted best practice processes. Further development of this initiative is likely to include:

- a forum where industry players can exchange thoughts and share experiences;
- the collection and dissemination of best practice information to the industry in the form of case studies, policy-level research, publications and conferences; and
- benchmarking industry performance, so that the industry can measure, identify, and improve on weaknesses.

With widespread support from the New Zealand construction industry, and a well directed innovation programme, CAE is hopeful that a New Zealand programme can emulate the success of Constructing

Constructing Excellence Demonstration Projects' 4 yr average Performance	Potential Benefits for the New Zealand Construction Industry ($13.5 billion)
Client Construction Cost Demonstration project costs are 6.0% lower than industry average	If one third* of the industry adopts best practice principles, client costs can be reduced by up to $270 million
Safety Demonstration project accident rates are 61% lower than industry average. *Note: UK estimates put accident costs across the industry as 8.5% of turnover*	If one third* of the industry adopts best practice principles, safety costs can be reduced by up to $233 million
Profitability Demonstration projects achieve 2 per cent more profit than the industry average	If one third* of the industry adopts best practice principles, there can be an increased profit of up to $90 million

* One third estimate used as a target for the CAE programme

Table 7: The NZ economy can benefit from improved efficiency

Excellence in the UK and other established international programmes.

In support of the initiative, Table 7 sets out the potential benefits that might be gained from a fully integrated national programme. Adding up the total of potential benefits to the industry yields a 4.4% or $593 million efficiency gain. This is a conservative estimate with the assumption of only one third of the industry participating within just three key areas. The flow-on effects from this efficiency gain has the potential to contribute at least another $712 million to the New Zealand economy derived from findings in Chapter 4. The Constructing Excellence demonstration projects were able to measure demonstration project performance improvements by analysing and comparing key performance indicator (KPI) data collected from construction projects throughout the industry.

The CAE Demonstration Programme

In 2001, CAE set out to promote new methods of construction procurement and delivery in New Zealand. Demonstration projects around New Zealand have been recruited and studied. These demonstration projects have adopted innovative approaches to project delivery, and the programme aims to measure the benefits and publicise them to a wider audience. The intended outcome of the programme is to encourage wider uptake of innovative methods from within the industry. It is CAE's belief that these benefits can be extended throughout the industry should it achieve wider uptake. CAE's demonstration projects are featured in Appendix 4.

As part of this study, the author conducted interviews with representatives of three of the demonstration projects:

- Papatoetoe Undergrounding Project with Vector project managers;
- Auckland Airport Runway Refurbishment works with Auckland Airport engineering manager; and
- Grafton Gully Project with key personnel from the Freeflow Alliance team.

In conducting the interviews, the author was able to establish that participants in all three demonstration projects were happy with the way the projects had advanced. All three projects were delivered with no problems in terms of scope, budget and time. Specific examples are elaborated in Appendix 4. The five drivers of change described in the previous chapter were also apparent in all three projects. The two alliance examples, Vector and Freeflow, both shared the same views that the benefits of setting up an alliance far outweighed the costs. Auckland Airport's project manager said that he would not have wanted the works to be procured under any other method after the success of partnering. KPI data collection is critical to finalising the potential benefits that can derive from best practice principles. All demonstration projects collect KPI data, but finding common metrics and a basis for direct comparison to benchmark

between projects is a significant challenge.

9.2 Other New Zealand Organisations

There are other organisations in New Zealand apart from CAE with construction related research agendas. The following outlines some of these organisations and their research interests:

The Building Research Association of New Zealand Incorporated (BRANZ)

BRANZ is an industry association, wholly owned and governed by the New Zealand building and construction industry. The majority of funding comes from the Building Research Levy and the Research for Industry Fund of the Foundation for Research Science and Technology. BRANZ uses these funds and fees collected from contract works to undertake research on behalf of the building industry. For the year ended March 2003, BRANZ had an operating income of $12.9 million, where $6.8 million ware collected from levies, $6.0 million from client fees, and the remainder from interest earned.

BUILD magazine, a BRANZ publication, conducts an annual survey on industry needs. The survey results have a significant influence in terms of priority setting on the research carried out by the organisation. The survey results and methodology was published in the October/November 2003 issue of BUILD (see Appendix 5). Results show domestic construction such as building envelope and materials performance represent the interest of the majority. BRANZ offers an important contribution to the New Zealand construction sector.

Ingenium

Ingenium is a technical group of the Institution of Professional Engineers of New Zealand (IPENZ), and exists primarily to uphold and improve the status of local government engineering in New Zealand. Its members are exclusive to those who provide engineering services to local government. Topics of interest to this organisation include asset management and contract management. Ingenium disseminates information through publications, seminars and conferences. With the Local Government Act 2002 focusing on asset management planning, in which procurement is a major component, CAE's programme would be likely to be of interest to Ingenium.

Ingenium is sponsored by high profile industry players such as: Fulton Hogan, Works Infrastructure, Opus, MWH, Hynds, Higgins, Meritec, Humes, Beca, Apex, GHD and CityCare.

Construction Industry Council (CIC)

CIC is the amalgamation of many major and high profile professional and trade organisations linked to the building and construction industry. From its 2004 research agenda, the group has expressed interest in a wide range of industry issues such as building materials, customer needs, safety and health, sector processes, and regulatory reforms. Under the sector process area, CIC plans to conduct research into procurement methods, project management, value engineering, life cycle costing, defects, and on-site skills.

The CIC research agenda also showed that the organisation expressed interest in collaborating with construction research centres, such as the proposed Collaborative Centre for Property and Construction Innovation, co-ordinated by UNITEC. This implies that CIC should also be interested in collaborating with other organisations with similar interests.

Universities and Learning Institutions

The University of Canterbury is providing substantial input to the CAE programme through the work of Dr Jason Le Masurier. An associated initiative is UNITEC's proposal for the Collaborative Centre for Property and Construction Innovation. Although construction management courses are common in civil engineering undergraduate degree courses, interest in post graduate research has been low. Research from universities and learning institutions could potentially provide valuable content for CAE's programme. CAE, in turn, offers an alternative channel for university staff to link with industry leaders as well as assistance in

post graduate programmes. This report is a good example of collaboration between the University of Canterbury and CAE for mutual benefit. Some possible areas for research include:

- Implications of improved productivity and efficiency to the multiplier effect from major construction projects.
- Buildability constraints on major infrastructure works.
- Efficiency of the New Zealand construction industry
- Compatibility and collaborative working arrangements with public sector procurement policy
- Establishing generic industry KPIs to allow direct comparisons to be made between projects
- Knowledge management within companies and within the sector
- Detailed comparisons of the New Zealand construction industry with other countries.

10 Conclusions

The building and construction industry is a sizable and significant contributor to New Zealand economic wellbeing. Not only is the industry important to economic performance, but also activity within the industry determines the way New Zealander's go about their daily business and lifestyle opportunities. The significant capital investment channelled through the industry is, on its own, a compelling reason for the country to invest more in improving industry capability and enhancing production efficiency.

Of concern to the author in completing this work, was the apparent lack of sector level research and published data related to industry effectiveness and excellence as pertains to New Zealand. This lack of published material perhaps reflects perceptions of the industry as a service industry rather than as a vital component of New Zealand's economic engine room; and the broader perception of the industry as simply a price taker rather than a value creator. In this environment it is no wonder that the traditional problems of the industry such as spiralling costs, time overruns, client dissatisfaction and low profit margins drives behaviours. The limited extent of construction management teaching and research at tertiary level is also a matter of concern.

The different interviews of industry players undertaken during the course of this study reinforced these negative perceptions of the industry in respect of its image as a desirable career option, overall poor commercial performance and perceived lack of integrity of some engaged in the sector. The author believes that more companies in the industry must realise that people are their greatest asset. Companies who make a commitment to their people, have respect for all participants in the supply chain, and create a working environment based on mutual interdependence and trust will develop the highly capable managers and supervisors required for world-class delivery and construction performance.

Finally, it must be concluded that New Zealand is not doing enough to understand the dynamics of the industry and the drivers for change. The analysis contained in this report clearly established the very significant contribution made by the industry at a national economic level, yet government support for research and development is minuscule when compared with other related economies. More needs to be done to change attitudes and thinking. The significant challenge of a largely fragmented industry needs to be overcome and collaborative programme for change adopted with construction excellence as a key theme. International experience clearly establishes the very significant benefits that have accrued from construction innovation programmes. In the NZ context the potential benefit stream is estimated to be of the order of $1.3 billion.

There is a huge value to be gained if we get it right. The work of CAE and others is a first step in the process. Their efforts need to be supported, and excellent performance within the industry celebrated and rewarded.

11 References

Reports & Journals

Constructing Excellence: Demonstration Summary, www.constructingexcellence.org.uk/productivity/summary.jsp

Construction Lean Improvement Programme, www.constructingexcellence.org.uk/service/clip/default.jsp

CRC, 2003. *CRC Strategic Plan 2003-2008*, brochure, CRC, June.

Duncan, J, 2003. 'Industry Research - Needs Survey 2003', *BUILD*, October/November 2003, p80, Building Research Association of New Zealand.

Egan, J, 1998. *Rethinking Construction - The Report of the Construction Task Force*.

Groak, S, 1992. *The Idea of Building*, E&FN Spon.

Nana, G, 2003. *Assessment of the Economic Impact of Efficiency Improvements in Building and Construction*, BERL August.

Nana, G. *The JAONNA model*, Research Project on Economic Planning, Victoria University of Wellington.

OECD data, Australian Bureau of Statistics. www.abs.gov.au

OECD Observer, 2003. 'Main Economic Indicators: Comparative methodological analysis: Vol 1 2001 OECD', OECD in Figures (www.oecdobserver.org).

Page, I, 2003. 'Building New Zealand's Economy', *Build,* December 2003/January 2004, p46, Building Research Association of New Zealand.

Property Council of Australia Ltd, 2001. *Projects as Wealth Creators - Drivers of Project Excellence*.

PSIB, 2003. *Project Plan for a Research and Development Programme*, Process and System Innovation in the Construction Industry.

PWC, 2002. *Innovation in the Australian Building and Construction Industry – Survey Results*, PWC.

Statistics New Zealand & MoRST, 2002. *Research and Development in New Zealand 2002*, www.morst.govt.nz

Statistics New Zealand & MoRST, 2002. *Research and Development in New Zealand 2002*.

Statistics New Zealand, 2003. *GDP Figures 2003*, Quarter 3 release (current/chain volume, actual/seasonal, production/expenditure).

Statistics New Zealand, 2003. *Household Labour Force Survey*, Quarter 4 release.

Websites

Cooperative Research Centre for Construction Innovation:
www.construction-innovation.info

Constructing Excellence:
www.constructingexcellence.org.uk

Lean Construction Institute:
www.leanconstruction.org

Process and System Innovation in the Construction Industry (PSIB):
www.psib.nl

Competitive Building:
www.competitivebuilding.org

National Technology Agency of Finland (TEKES):
www.tekes.fi/eng

Provisional Construction Industry Co-ordination Board (PCICB):
www.pcicb.gov.hk

Construction Innovation Forum:
www.cif.org/index.html

BRANZ:
www.branz.co.nz

Ingenium:
www.ingenium.org.nz

Construction Industry Council (CIC):
www.nzcic.co.nz

13 Appendices

Appendix 1: Research Methodology

a) Work Programme

b) Key Personnel

c) Meetings

d) Demonstration Project Interview Questions

Appendix 2: Comparison of R&D Expenditure among OECD Countries

Appendix 3: Demonstration Project Case Studies

a) Papatoetoe Undergrounding Project

b) Auckland Airport Runway Refurbishment Works

c) Grafton Gully Project

Appendix 4: BRANZ Research Survey Results

Appendix 1: Research Methodology

Work Programme

The author's work programme for the project research period was as follows:

1. Situation analysis of the NZ environment and CAE

a Current issues

b Strategic goals

c Identify gap between NZ and overseas programmes

d Recommendations

2. Overview of other international construction industry programmes

a Budget allocated

b Funding sources

3. "Best Practice in Construction Procurement and Delivery" Programme

a Understand administration and operations

b Budget for running the programme

c Look into how the programme fits into CAE's Infrastructure Systems programme

4. Demonstration projects

Study on:

- Reason(s) for choosing the partnering or alliancing method
- Challenges encountered by the projects and the solutions found
- Cost savings
- Construction time taken
- Cost and Time Predictability
- Productivity
- Turnover and profitability
- Quality and defects
- Client satisfaction
- Intangible benefits
- Things that went wrong and how they can be avoided
- Comparisons with "business as usual" projects

Meetings

- Demonstration project meeting 7/10/03
- Mike Geale 7/10/03
- John McCarthy 7/10/03
- Demonstration project interviews - Vector 17/11/03

- Demonstration project interviews - Auckland Airport 18/11/03
- Demonstration project interviews – Grafton Gulley 19/11/03 and 21/11/03
- CAE industry meeting attended by representatives from Fletcher Construction, NZ Contractors Federation, Transfund, and Local Government– 25/11/03
- Richard Crooks 5/3/04

Key Personnel

Name	Organisation	Position
Dr George Hooper	Centre for Advanced Engineering	Executive Director and Project Supervisor
Dr Jason Le Masurier	University of Canterbury	Senior Lecturer and Project Supervisor
Ernesto Henriod	Centre for Advanced Engineering	Programme Advisor
Ross Malcolm	Vector	Project Manager
Douglas Ray	Vector	Project Manager
Paul Duffy	Auckland International Airports Ltd	Engineering Manager
Kim Barret	Freeflow Alliance	Project Manager
Craig Turner	Freeflow Alliance	Liason Manager
Richard Quinn	Transit	Project Manager
Lief Klassen	Freeflow Alliance	Stakeholder manager
Letitia Drury	Freeflow Alliance	Environmental Manager
Mike Geale	Mainzeal	Auckland Regional Manager
John McCarthy	Audit New Zealand	Auditor
Stewart Rix	Leander Capital Limited	Managing Director
Russell Kenley	Unitec Institute of Technology	Senior Lecturer
Richard Crooks	Opus	Southern Regional Manager
Stephen Hickson	University of Canterbury	Economist / Lecturer

Demonstration Project Interview Questions

1 Can you give me a brief background on the project? (project briefs, PowerPoint presentations and brochures would be helpful)

2 What was the reason(s) for choosing a different type of procurement route / collaborative project relationship?

3 What benefits did the project achieve that can be attributed to the procurement route / relationship, in terms of:

- Cost savings
- Construction time taken
- Cost and Time Predictability
- Productivity
- Turnover and profitability
- Quality and defects
- Client satisfaction
- Intangible benefits e.g. communication, morale

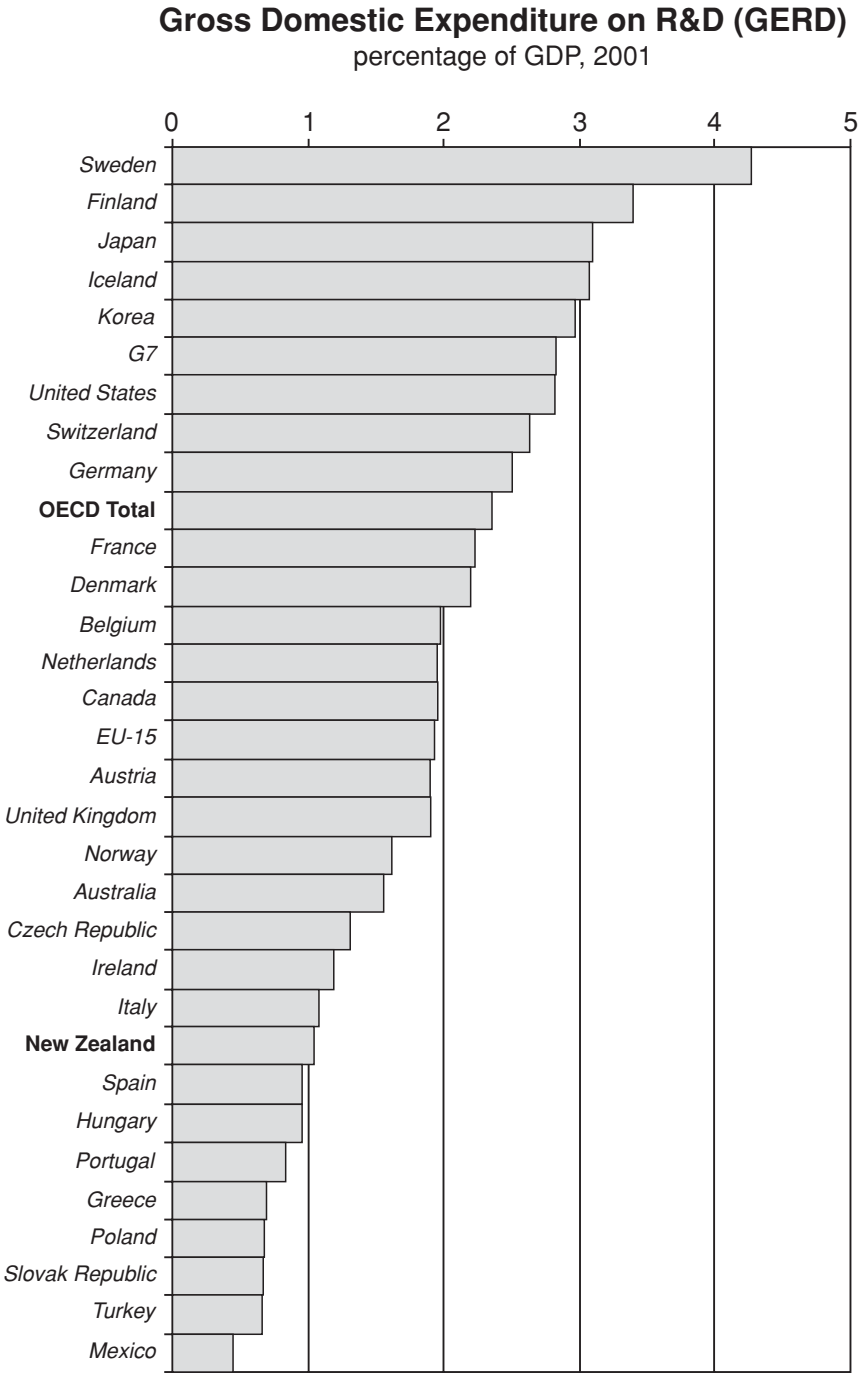
4 Besides the benefits discussed, how else did the project perform differently compared to "business as usual"?

5 What challenges were encountered and how did the team overcome them?

6 Did anything go wrong, and if so how could this have been avoided?

7 Was there any additional cost or extra effort required as a result of the collaborative approach that would not have been required had the project followed a traditional procurement route / contract form?

Appendix 2: Comparison of R&D Expenditure among OECD countries [22]



[22] Reproduced from OECD Observer 2003

Appendix 3: Demonstration Project Case Studies

Papatoetoe Undergrounding Project - Auckland

Main Parties Involved:

- Vector
- Telecom
- Manukau City Council
- Works Infrastructure
- Manukau Water

Outline:

The Papatoetoe Undergrounding project is the most ambitious project of its kind undertaken in NZ. The Papatoetoe area covers 2200 homes in 43 streets totalling 13 kilometres and the project involves the simultaneous installation of water, gas, power and telecommunications underground, while completely revitalising the area at the same time. The main parties involved were Vector, Telecom, Manukau City Council, Works Infrastructure and Manukau Water. These companies wanted to share the financial and logistical risks, and wanted a procurement route that would best deliver the results required, so they formed an alliance under Vector.

Working under an alliance led to better understanding, work flexibility, opportunities to save costs and good working relationships. The project was highly successful and demonstrated that both utilities and local bodies win when they do what customers expect, which is to work together for their mutual benefit.

Benefits:

- Cost – repetitive administrative costs were eliminated, such as the need for several call centres and traffic management. The project was completed on budget with no significant variations.
- Public disruption – by having the works done simultaneously, this project reduced the disruption it would have otherwise caused had operations been carried out separately. The regular project meetings ensured that work programme was optimised and disruption to the public was kept to a minimum.
- Work continuity – there were no in-house disputes because of the “no blame” culture of an alliance; no work stoppages; no lost time injuries; and no environmental issues.
- Satisfied stakeholders – the residents were happy with the end result and were carefully looked after throughout the project. Customer complaints were often resolved within five working days.

The Challenge:

The works, if done separately, were technically simple for the respective companies, who have had many years of experience. The main challenge was the logistics and integration of the project’s different facets. The companies wanted the works to be carried with no environmental issues, minimal disruption to the residents, and no disputes within the alliance. Preserving working relationships among the alliance was one of the main goals.

The Solution:

A functional alliance requires a high performing team, so only the right people with the appropriate calibre and experience were recruited to form the alliance. Key personnel were even identified as early as the tender evaluation stage. The project managers had regular progress meetings to ensure the productivity and work programmes were optimised.

The “no blame” environment of an alliance created a different frame of mind for the people working on the project: the project team were constantly “solving problems rather than stuck with problems”. Good faith, common goals and shared core values were used to cover any “grey areas” in terms of responsibility under the alliance. Key performance indicators (KPIs) were also put in place to encourage better participation of the partners and to ensure that project partners were happy, environmental standards were met, commercial statistics were on track, and the public was satisfied.

A single call centre handled all customer enquiries regarding every aspect of the works. By doing so, there was a single communication channel between the residents and the people carrying out the works, enabling people to be informed better, and issues to be addressed quicker. The single call centre also meant that project managers had a “one stop shop” to deal with any problems.

Future Development:

The Papatoetoe project took 9 months to complete. It is only 1.5% of a total programme of utility upgrades, so the benefits of a high performing team and good working relations will be carried forward onto the next projects with the aim of achieving continuous improvement.

Auckland Airport Runway Refurbishment Works - Auckland

Main Parties Involved:

- Auckland International Airport Ltd
- Airways Corporation New Zealand Ltd
- Beca Carter Hollings and Ferner Ltd
- Air New Zealand
- Brian Perry Ltd
- Kaipara Excavators Ltd

Outline:

The Auckland airport runway was nearing the end of its service life because it was built in the 1960’s and was designed for smaller aircrafts. Throughout the years, the runway has been extended to accommodate larger aircraft, but the concrete slabs at the central section of the runway had to be replaced in April 2002. The refurbishment works required the closure of the main runway after the conversion of the main taxiway into a temporary runway. Thousands of people travel through Auckland’s airport daily, so the refurbishment was planned over a period of two and a half years to ensure minimal disruption to passengers and normal operations.

A partnering approach was used for the procurement and delivery of the project. Rather than taking the traditional tendering route of identifying the lowest bid contractor, they opted to go into a partnering arrangement with their preferred contractors who had performed well in the past. The contractors were customer focused.

Benefits:

- Time – The project was completed five days ahead of schedule due to the extensive planning having considered an extensive array of potential operational impacts. Backup plant was utilised to speed up construction.
- Cost – Prices were negotiated upfront with the contractor. There were very few variations and claims.
- Client Satisfaction – The clients were satisfied with the end result and the early completion time was a bonus for the end users
- Work Continuity – There were no programme delays and no safety accidents.

The Challenge:

The refurbishment works had to be carried out without any operational problems and delays because it was critical to the core operation of the airport. All specifications had to be met because passenger safety could not be compromised.

The Solution:

Communication and detailed planning was the key to delivering this project successfully. All levels of parties participated actively in progress meetings, right down to the people working on site. An integrated delivery team was formed at the earliest stages of the project with the designers and contractors working together from the start. Clear and constant communication gave management the flexibility to optimise their work programme through faster decision making processes and allowed them to "design out problems".

There were daily meetings on past, present and future progress, and how they impact on one another. The planning of the works involved those actually responsible for the site works and extensive stake-holder consultations were carried out. A risk consultant was employed to perform an extensive risk analysis involving all stakeholders. With detailed risk analysis, the project team was able to prepare contingency plans for a wide range of potential outcomes.

Grafton Gully Project - Auckland

Organisations Involved:

The main parties involved in the project were:

- Transit New Zealand
- Fletcher Construction Company Limited
- Higgins Contractors Limited
- Beca Carter Hollings and Ferner Limited

These four organisations joined together to form a delivery team called the Freeflow Alliance, termed the "Alliance" in this case study.

Background:

The Grafton Gully Project is one of Transit New Zealand's Central Motorway Improvement (CMI) projects that aim to improve the efficiency and safety of Auckland's central city motorway. The project cuts out the doglegs at the Grafton Road off ramp and the Stanley St / Strand intersection, and separates the cross-gully traffic from the main flow between the Ports of Auckland and the motorway. The project itself is a huge undertaking with the construction of three bridges, one underpass, 6,000m^2 of retaining walls, and 80,000m^2 of new pavement. One of the bridges constructed carries the Newmarket branch rail line over the Strand road alignment. The construction involved this bridge being built beside the original rail tracks and then slid into final position on teflon pads using several 200 tonne jacks.

The Alliance was formed in late 2001, to complete the full delivery of the Grafton Gully Project. The alliancing contract model for project procurement and delivery was the first of its kind to be implemented on a public sector project in New Zealand. The Alliance's work also involved cooperation with ten utility companies to relocate and put in place service lines for the new traffic layout, which was carried out simultaneously during the construction period.

The Challenge

The Alliance had to deliver a new major motorway link in an already congested section of highway, with many stakeholders and utility providers involved, as well as a significant amount of earthworks to be completed. The planning and management of traffic flows was a critical task, with 40,000 vehicles

passing through the site per day, throughout the project's life. As the site was located near a residential and commercial area, the Alliance had to make sure that there would not be any significant environmental and noise issues resulting from the construction works.

The Solution:

The structure of the Alliance is such that it promotes innovative thinking, open and honest communication, and mutual support. The owner, designer and constructor are all based under the same roof, which allowed quick decision making, and decisions that were in the best interest of the Alliance, rather than an individual party. The flat organisational structure made it easier for each party to communicate with each other and solve problems. A unique work culture was created, based on the concept of collective responsibility that was both new and refreshing for the participants. With open book transactions, constructors working on the project had less pressure to under-resource, which ensured that no safety component was being overlooked.

The search for innovative techniques, and a drive to achieve value for money provided the impetus for value engineering exercises, that helped the project stay below budget even after unforeseen risks materialised. Transit as a client and owner-participant, was very much involved on site and with integrating the project delivery team. The collective reputation of the Alliance also helped fast track city council administrations and increased their collective bargaining power. The Alliance responded well to environmental and noise issues such as having spill kits strategically placed around the site; filter material placed over storm-water inlets; a cleaning system that washes down equipment wheels before they exit the site; and a fully-ventilated sound-proof portable container unit specifically designed so that workers can perform noisy activities at night.

The Benefits:

Through the measurement of key performance indicators, it has been demonstrated that the following benefits have accrued, as a direct result of the alliance contract model:

- Safety – There were no serious accidents on the project, and very few lost time injuries. A very strong safety culture was developed on the project.
- Cost – The works were completed approximately 7% below the target out-turn cost, with savings achieved through innovative design, the close collaboration of the design and construction team and active management of risks and opportunities.
- Time – The works were finished ahead of schedule. The project was handed over in February 2004, 1.5 months early.
- Work Pride – There was a strong sense of pride amongst employees in the task they were doing. Everyone felt like part of the team.
- Environmental – The Alliance worked two winter earthworks seasons, to the delight of the Auckland Regional Council

Quality, Aesthetics, Traffic and Stakeholders - An unprecedented amount of positive feed back from the community to Transit and the Alliance on the lack of traffic disruption, the tidiness of the site and the high quality look of the project.

research

by Dr John Duncan,
BRANZ Manager,
Building Industry Research

Industry research-needs survey 2003

For the third year in a row the issues surrounding weathertightness dominated the BRANZ industry needs survey. Each year BRANZ surveys the industry to identify where new information is needed and the topics that should be targeted. John Duncan reports on the results.

In March 2003, survey forms were sent to 181 industry participants, including designers, builders, subcontractors, manufacturers and building owners. The response rate was 36%. Similar questionnaires have been used since 1997, but each year BRANZ changes a significant fraction of the survey group, so that it is not continually testing the views of an 'in-group'. Of those who included their name on their 2003 reply, 56% were new respondents (or if they replied in 2002 did so anonymously).

This survey applies a broad filter to industry opinion, but the unanimous importance of weathertightness demonstrates the extent to which the industry recognises it has a major problem. Over the past decade of BRANZ surveys, the question of materials performance has always been in the top two or three general areas, and industry concern has no doubt heightened anxiety about the rapid degradation of some materials. This survey was completed well before the release of the proposals for the revision of Clause B2 by the BIA.

The increase in specific topics related to environmental issues is the continuation of a slow trend over the past few years.

Table 1: Ranking of the importance of means of information transfer.

Means of transfer	2003[1]	2002[1]
Printed Bulletins/Good Practice Guides	67%	68%
Through *BUILD* magazine	67%	52%
BRANZ seminars	41%	48%
BRANZ website	35%	34%

[1] *Percentage of those who graded the area as 1 or 2 on a 1–7 scale, where 1 is very important.*

Table 2: Ranking of importance of general research areas.

General area	2003[1]	2002[1]
Building envelope	85%	77%
Materials performance	76%	72%
Energy	61%	52%
Practices on site	50%	46%
Advanced technologies	48%	n.a.
Environmental issues	44%	40%
Fire safety science and engineering	42%	40%
Acoustics	41%	29%
Building user expectations	38%	45%
Internal environments	33%	35%
Building services	33%	37%
Building user behaviour	33%	33%
Structural engineering	32%	23%
Earthquake engineering	30%	33%
Economics/demographics	27%	19%
Re-use of existing buildings and structures	26%	38%
Project management	22%	23%
Information management	19%	17%
Geotechnical and hydraulic engineering	15%	21%

[1] *Percentage of those who graded the area as 1 or 2 on a 1–7 scale, where 1 is very important.*

Methodology

The questionnaire asked respondents to rank on a 1–7 scale (where 1 is very important and 7 is totally unimportant) two areas: the information transfer methods that BRANZ uses; and the relative importance of a range of general topics. It also asked for a simple 'tick the box' response on whether items on a list of 109 specific topics were important.

Results

Table 1 shows the results about information transfer mechanisms, and compares them to the 2002 results. The survey also asked for suggestions for new publications and seminars. Weathertightness and associated issues dominated the suggestions.

Table 2 shows the overall ranking given to the general areas and the percentage of people who rated that area either 1 or 2.

Table 3 lists the 11 specific topics, from a list of 109, that were marked as important by over 50% of respondents. (The average percentage score of the 109 topics was 31%; down from 33% in 2002.)

Table 3: Specific topics ticked as important by 50% or more of respondents.

Specific topic	2003	2002
Joint and junction detailing in building envelopes	89%	78%
Rain penetration through the building envelope	80%	82%
Life cycle assessment of environmental impacts of materials and structures	61%	42%
Condensation and similar moisture problems	59%	69%
Acoustic separation	59%	62%
Durability of timber frames	59%	57%
'Good practice' database of design details	53%	74%
Assessment of remaining durability of existing buildings and structures	53%	49%
Economic life cycle costs	53%	46%
Effects of building user on energy-efficiency measures	53%	45%
Actions of materials on one another	53%	45%
Consequences of new environmental legislation	52%	42%